DATA COLLECTION FOR THE NORTHERN HEMISPHERE MAP SERIES

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ABSTRACT

A general review is made of the Northern Hemisphere Map Series with emphasis upon data collection from multiple sources. The advantages of an historical analysis are presented with a comparison of analyses as prepared operationally, with immediate deadlines, and historically, after additional data are available.

1. INTRODUCTION

HISTORICAL BACKGROUND

The first international collection and publication of meteorological data can be traced back to 1875, when, on July 1, the daily issue of the "International Bulletin of Simultaneous Reports" was begun in Washington under the auspices of the Chief Signal Officer of the Army [1]. Three years later, with the cooperation of other countries, a series of international weather charts was published covering a portion of the Northern Hemisphere. This series continued through 1887.

While this early series is evidence of a definite interest in hemispheric weather conditions as far back as almost a century ago, it took the rapid advancement of aviation assisted by the impetus of World War II, and the funds made available by the war, to launch an extended and serious program to prepare a series of weather maps of the Northern Hemisphere on an historical basis. With demands for hemispheric and world-wide weather knowledge increased in general, and the popularity of an "analogue" system to aid forecasting in particular, the U. S. Air Force, Navy, and Weather Bureau in the early 1940's began the mass production of what later enlarged into the "40-year series." This series, *Historical Weather Maps, Northern Hemisphere, Sea Level*, which began with the 1230 GMT sea level maps for January 1899, terminated with the maps for June 1939 mainly due to the disruption of hemispheric data collection during the period of World War II.

Through the use of the first extended series of historical weather maps*it became obvious that the value of this type of analysis, both as a research tool and as an historical record, would be greatly enhanced by a more careful analysis of more data, and by the addition of an upper-level chart. A project of this type was undertaken by the U. S. Air Force and resulted in the publication of the

*During the early 1940's three shorter series of maps were prepared and published under agreement with the joint Meteorological Committee (Army, Navy, and Weather Bureau). (1) *Daily Synoptic Series Historical Weather Maps, North America for the 10, 13, and 16 Kilometer Levels;* October 1932 through December 1940. (2) *Daily Synoptic Series Historical Weather Maps of the Northern Hemisphere, 5,000 Dynamic Meters;* October 1932 through December 1940. (3) *Daily Synoptic Series Historical Weather Maps of the Southwest Pacific, Sea Level,* 70° E Long.-145° W Long., 30° N Lat.-50° S Lat.; January 1932 through December 1934. These and other results of the wartime historical and normal map program have been summarized by Wexler and Tepper [2].

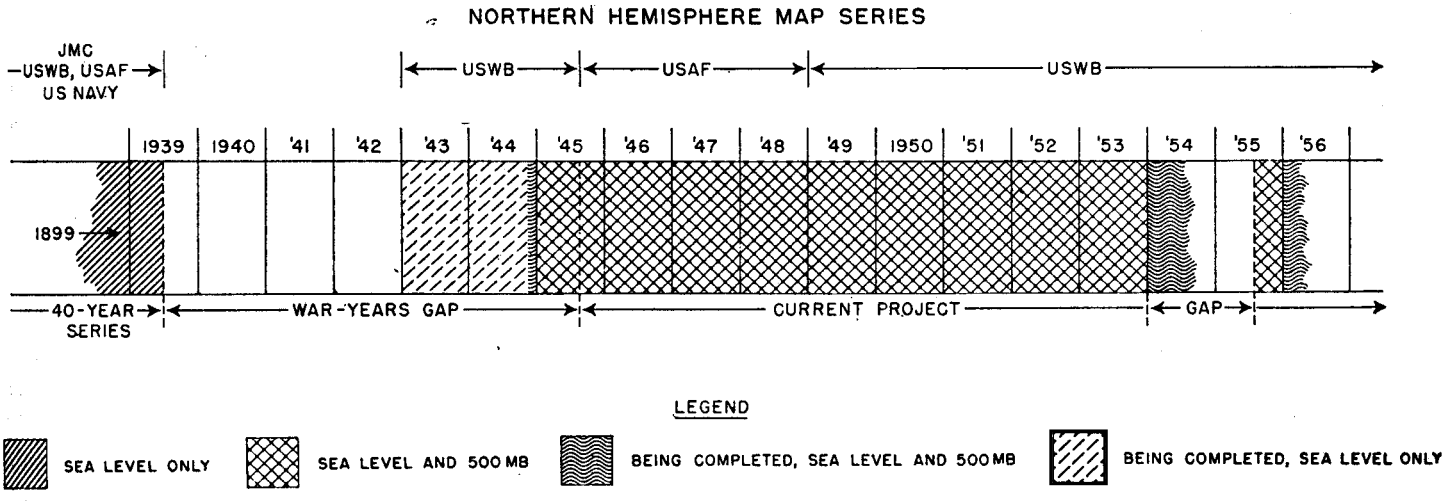

FIGURE 1.—Content and status of the Northern Hemisphere Map Series.

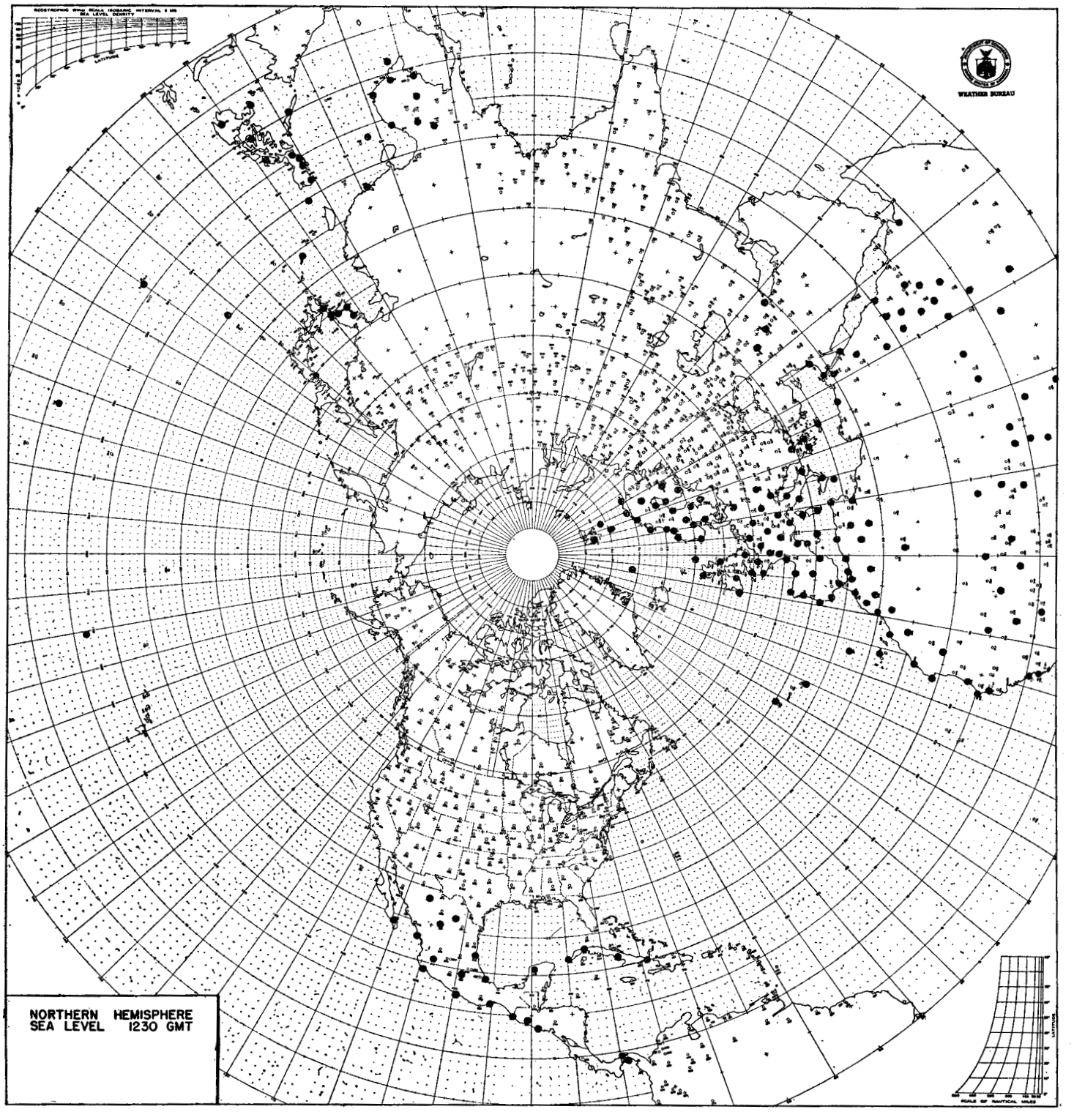

FIGURE 2.—Sea level 1230 GMT reports normally plotted from foreign code sheet source.

Northern Hemisphere Historical Weather Maps, Sea-Level and 500 Millibars for October 1945 through December 1948, with "Data Listings" publication beginning with this group (except for the November and December 1945 issues).

In the early months of 1949 new financial life was given to the project, and with the help of funds transferred from the U. S. Air Force and Navy, the Weather Bureau again began publication of both maps and data listings under the title *Daily Series, Synoptic Weather Maps, Northern Hemisphere, Sea-Level and 500-Millibar Charts, with Synoptic Data Tabulations*, the first issue being for January 1949. Most of this discussion will pertain to this "current" project, with emphasis on the July 1955 and subsequent issues.

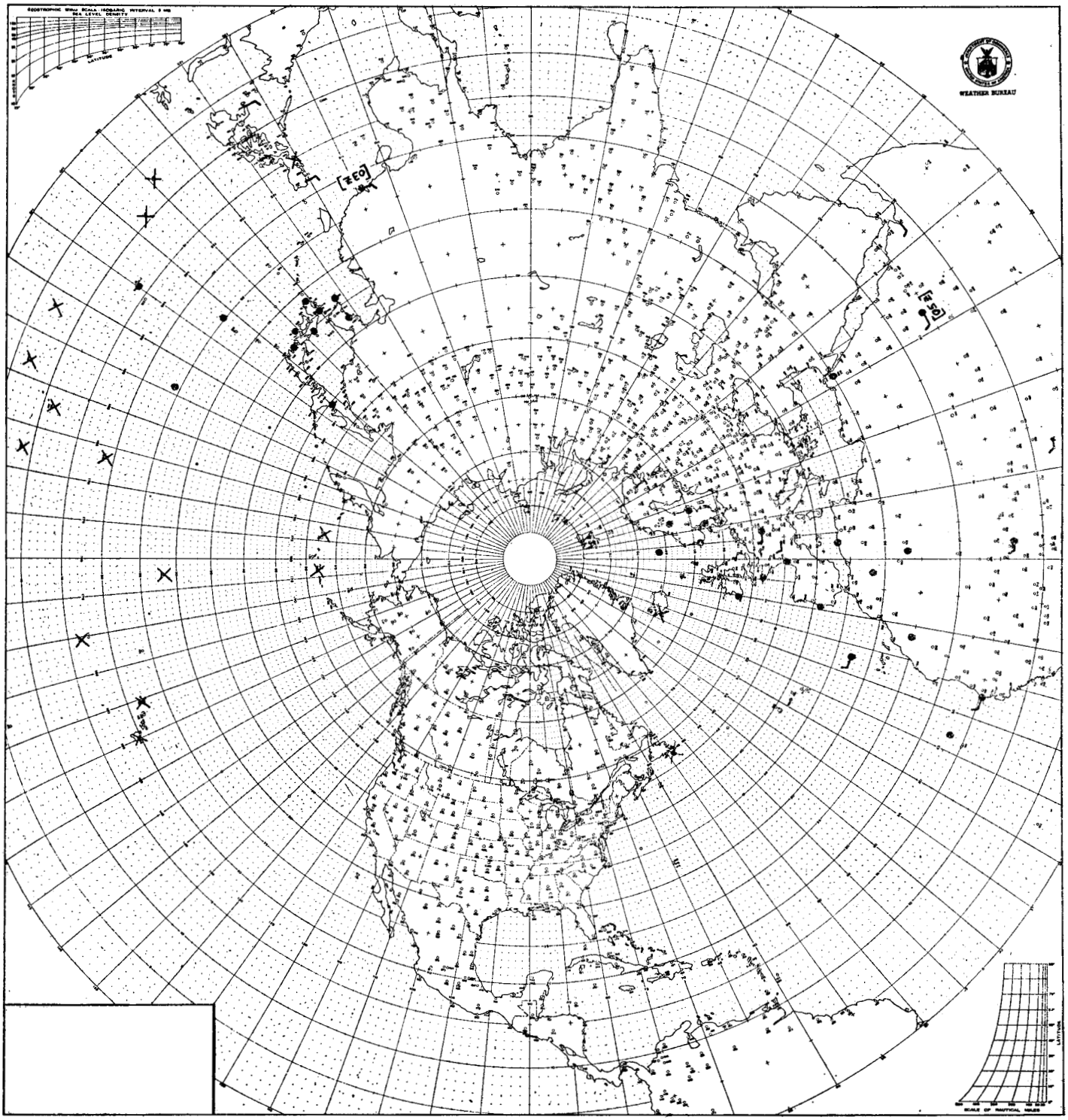

FIGURE 3.—500-mb. 1500 GMT reports normally plotted from foreign code sheet source. "X" plotted from original records. Wind barb shows pibal data only received from that station.

CURRENT SERIES

From the viewpoints of both an historical record of the weather of the Northern Hemisphere and as a useful tool for research, it is most commonly agreed that an historical series should be as long and as continuous as possible. Soon after the re-birth of the main series (January 1949) it became evident that due to irregular financial support it would not be possible to achieve a year-for-year production of the analyzed maps and companion tabulations of data. Rather than sacrifice the completeness and quality of the publications, it was decided that final production should be reduced to ten months per year, accepting the unavoidable and ever-growing backlog in the hope that facilities would sometime become available to "fill the

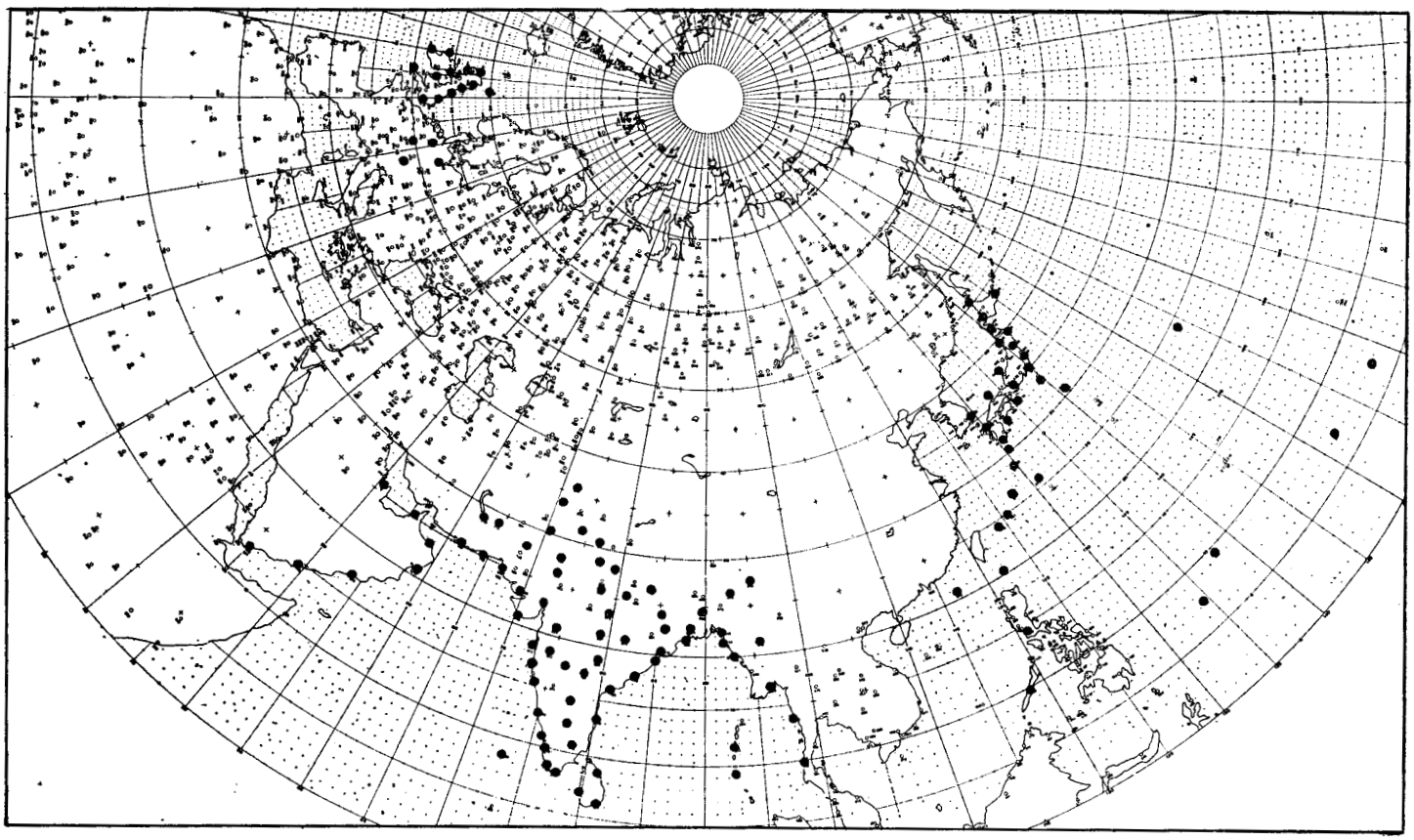

FIGURE 4.—Sea level 1230 GMT reports normally plotted from publications source.

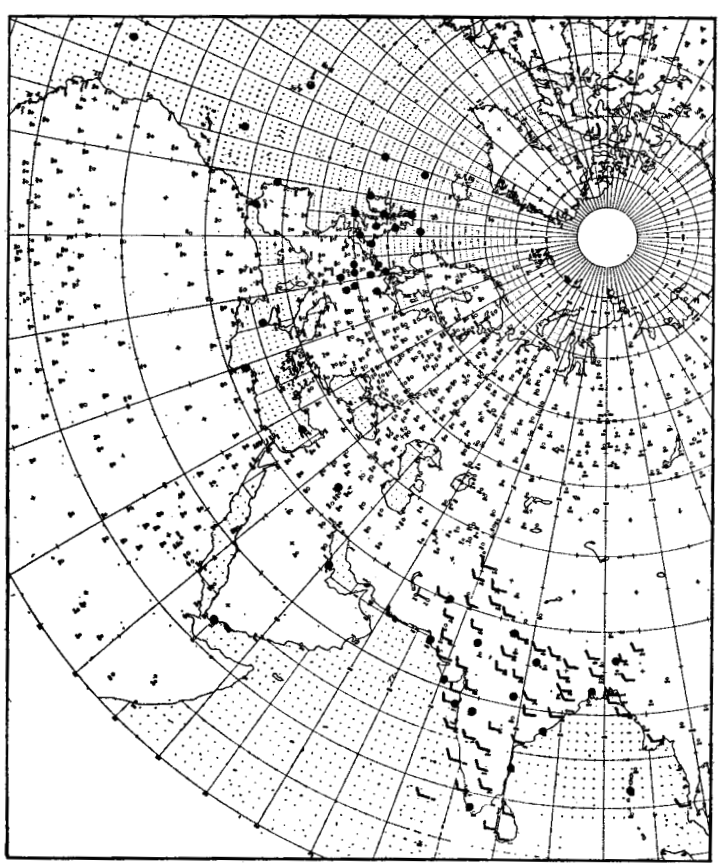

FIGURE 5.—500-mb. 1500 GMT reports normally plotted from publications source. Wind barb shows pibal data only received from that station.

gap." Operating under this production schedule, the "current" series became less and less "current".

During 1955 certain changes were made in the publications to achieve two main objectives: (1) a more nearly current issuance of both maps and data tabulations, and (2) a year-for-year production rate with no sacrifice of the quality of the final product. To accomplish these objectives the Plotting and Analysis Unit was moved from the Central Office of the Weather Bureau to the point of collection and tabulation of the data—the National Weather Records Center, and the form of the Data Tabulations (Part II) was changed so the printing could be done at the NWRC, thus expediting publication by relieving the load on the printing facilities in the Central Office of the Weather Bureau. In addition, techniques and procedures were streamlined throughout the entire operation. The price paid for achieving these objectives can be seen in figure 1 in the form of a break in the series from January 1954 through June 1955. However, with the help of funds transferred from the U. S. Air Force and Navy, analysis of maps to fill both this gap and the war-years gap is now progressing. It is planned to publish issues for these periods as facilities permit.

2. DATA COLLECTION

GENERAL

One of the advantages of an historical analysis and data listing program is the elimination of the restriction of only a few hours allowed for data collection by teletypewriter until analysis begins—as is necessarily the case in

all operational programs. Although the current project is committed to a 6-months lag between calendar date and distribution date of maps and data listings, some phases of editing and plotting of data actually begin during the first few weeks after the calendar date, and may extend to within 6 weeks of final publication in cases of unusually late receipt of data.

Data sources used may be grouped into four main categories: (1) Original records on file at the NWRC, and punched cards prepared on station. (2) Special report forms prepared by cooperating meteorological services in the Northern Hemisphere specifically for the Northern Hemisphere Series (referred to hereafter as "code sheets"). (3) Published data prepared by foreign meteorological services. (4) Radio and teletypewriter reports from all collections available including those received in the United States on standard teletypewriter and those shipped to the United States which are interceptions of Union of Soviet Socialist Republics broadcasts.

ORIGINAL RECORDS AND PUNCHED CARDS

The majority of reports for the United States, Alaska, and the Atlantic and Pacific ocean weather vessels operated by the United States, are acquired from punched cards which are prepared on station and checked for accuracy at the NWRC. Sea level data are plotted on the maps from these tabulations, and although it is not feasible operationally to plot the 500-mb. data from similar tabulations, these listings and original records are available as a data source in cases of a total absence of teletypewriter data or for checking in cases of dubious individual reports (see figs. 3 and 10). In addition to those mentioned above, punched cards prepared by Mexican and Pacific island stations are used in the preparation of the data listings for publication.

About half of the marine sea level reports used are plotted from tabulations of original ship weather observation logs which are received and processed at the NWRC.

Through the cooperation of the Canadian Meteorological Service, it has recently become possible to list in the Tabular Data section of the current publication, sea level and upper air observations for Canada from punched cards prepared in Canada and shipped to the NWRC. Because of the many problems connected with this exchange of data, Canadian data are plotted on the maps from the standard teletypewriter source at the present time (see figs. 9 and 10).

Because of the scarcity, and therefore greater relative importance, of upper air observations from the Pacific, available reports for the 500-mb. maps are plotted from original records (adiabatic forms with pressure-height computations) from these reporting stations (see fig. 3).

CODE SHEETS

Because of the desirability, from both an analytical and a climatological standpoint, of the regular receipt of sea level and upper air reports from the same stations, a program of data collection by use of special forms submitted with the cooperation of foreign meteorological services has been developed. While code sheets for only the 1230 GMT sea level observation are received, intermediate hours of radiosonde (including in some cases rawins and standard and significant level reports) and pilot balloon observations are received by mail on monthly forms. Reports plotted from this source are shown in figures 2 and 3. Of course, the stations shown send reports in this manner for the particular time and level of the maps; these reports in addition to reports for all other times and levels recorded are listed in the Data Tabulations. At present, about 40 foreign services are partici-

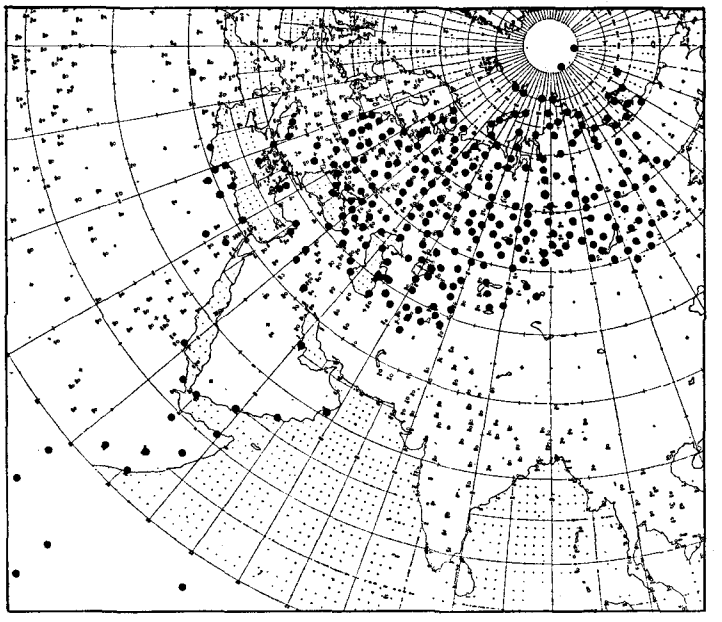

FIGURE 6.—Sea level 1230 GMT reports normally plotted from intercept teletypewriter source.

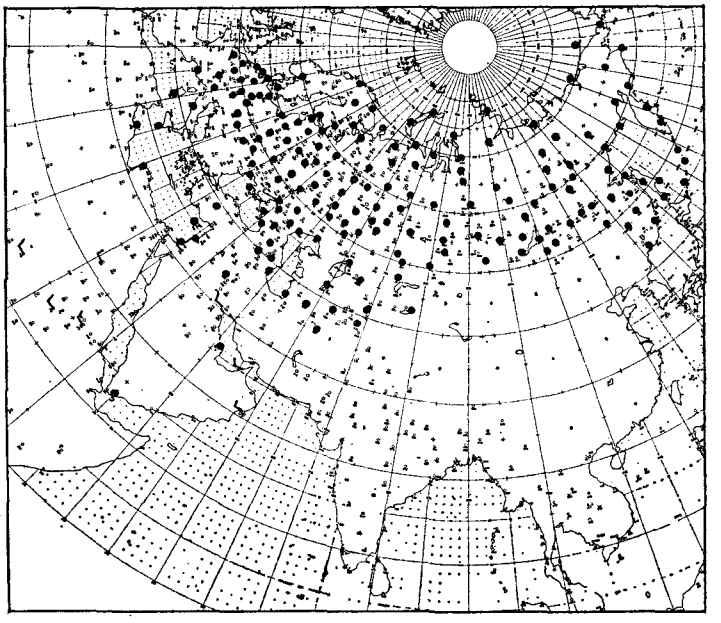

FIGURE 7.—500-mb. 1500 GMT reports normally plotted from intercept teletypewriter source. Wind barb shows pibal data only received from that station.

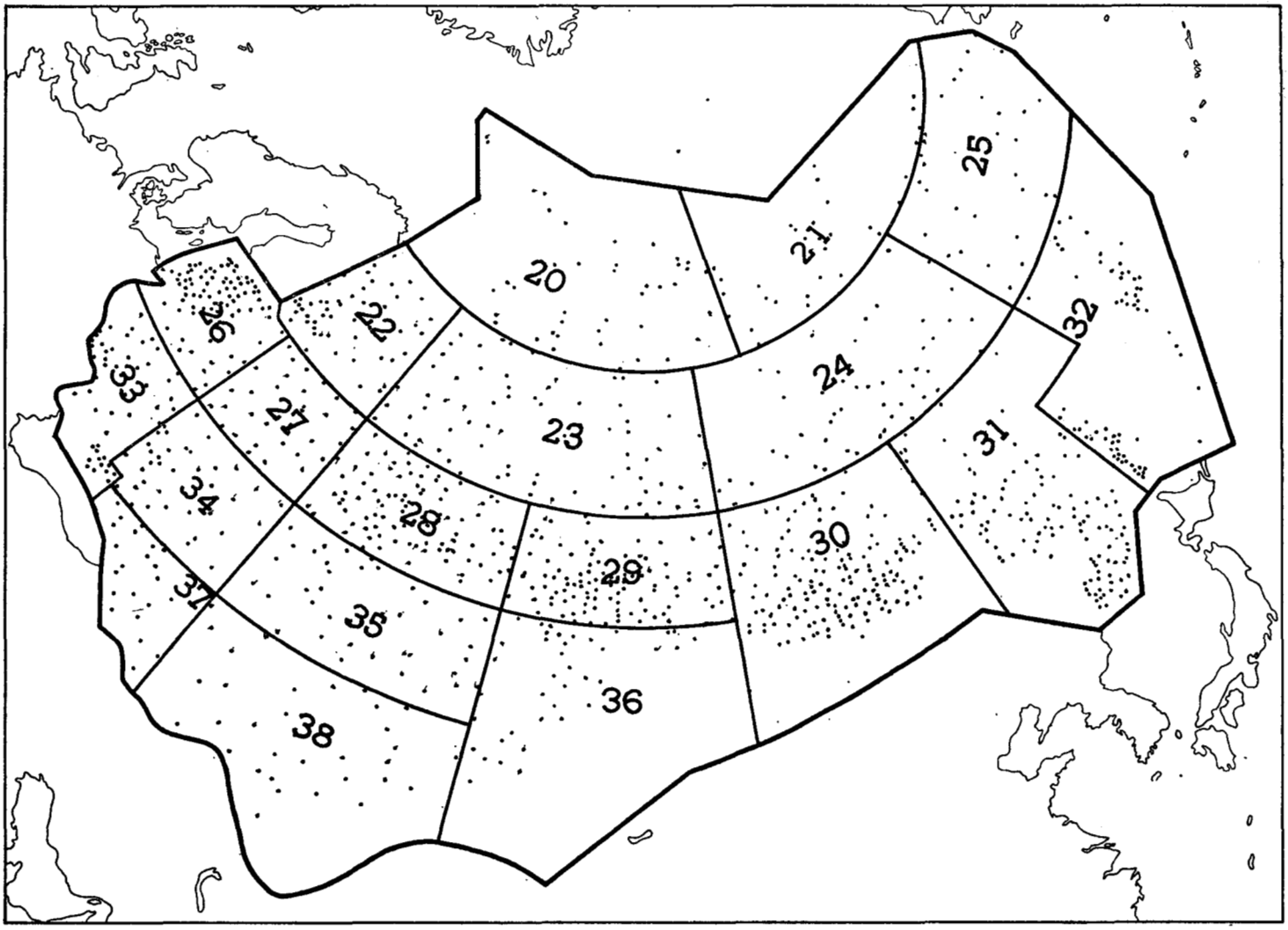

FIGURE 8.—Sea level 1230 GMT reports from Union of Soviet Socialist Republics available from intercept teletypewriter source.

pating in the upper air code sheet program and about 50 countries submit code sheets of the 1230 GMT sea level observation. This program is in a constant state of development and expansion.

PUBLICATIONS SOURCE

While many countries issue publications of meteorological data, the extremely wide variance of types, times, codes, and methods of presentation of these data makes it impossible to utilize all of the different publications or, in some cases, even all of the data in one particular publication. Many of these published reports include analyzed charts of many descriptions, and these are used as reference material during the analysis. Reports as shown in figures 4 and 5 are plotted from meteorological data published by Germany (including ship observations), Great Britain (including the Overseas Supplement to the Daily Weather Report), India, Japan, Portugal, Pakistan, Switzerland, and Malaya. Where practicable, data included in these sources are transferred to punched cards and included in the Data Tabulations.

TELETYPEWRITER SOURCE

As is shown in figures 6 and 7, the bulk of reports from the Soviet Union are received by radio teletypewriter. While these reports are received in the United States by a multiple relay system, the availability of the "intercept teletypewriter" source used is made possible through the cooperation of the U. S. Air Force installations in Germany, Japan, and Arabia, and a similar intercept station in Alaska operated by the Civil Aeronautics Administration which intercept broadcasts of weather reports made from the Soviet Union. While these reports are relayed on a regular schedule to the United States by radio, and then relayed by land-line teletypewriter to points within the United States, the originally intercepted material in teletypewriter form is eventually shipped to the NWRC, and this "original" material is then available for use by the Northern Hemisphere Project. Because of the elimination of the relays necessary to transmit these data from the overseas intercept points to stations within the United States, this intercept teletypewriter affords the most complete and consistent coverage of Soviet Union data.

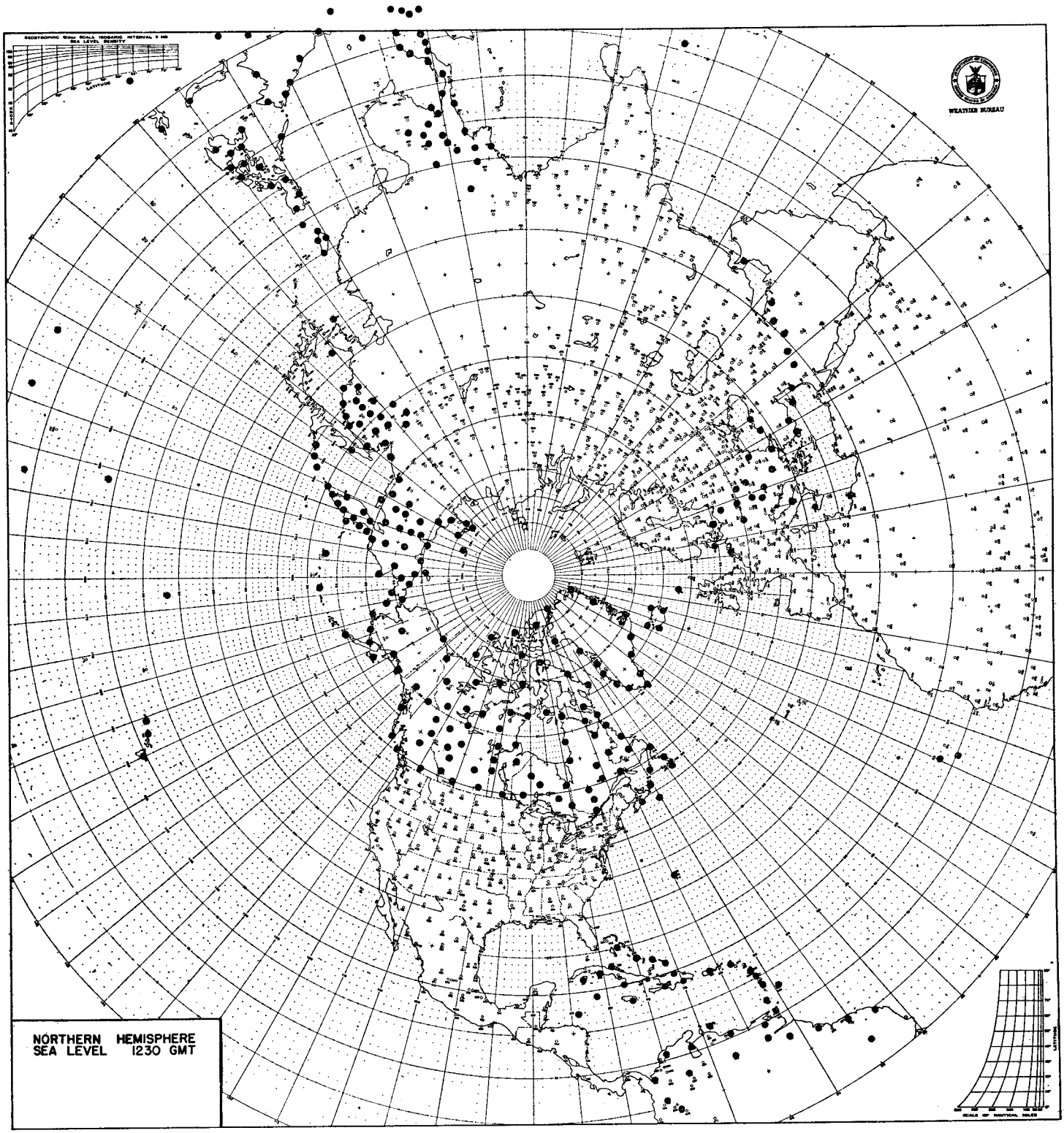

FIGURE 9.—Sea level 1230 GMT reports normally plotted from standard teletypewriter source.

The intense coverage of the Soviet Union afforded by this intercept teletypewriter source is shown in figure 8. While the fact that this coverage is for only one day chosen at random may detract from its representativeness on an average basis, it does show that on this day 1141 reports for the Soviet Union were available through this one source. Because of the physical limitations of the base maps used, about 300 of these stations are normally plotted on the current Northern Hemisphere sea level maps.

Figures 9 and 10 show the areas that must be filled-in from standard teletypewriter source as received at various weather centrals in the United States. As general insurance to obtain the most complete coverage possible for

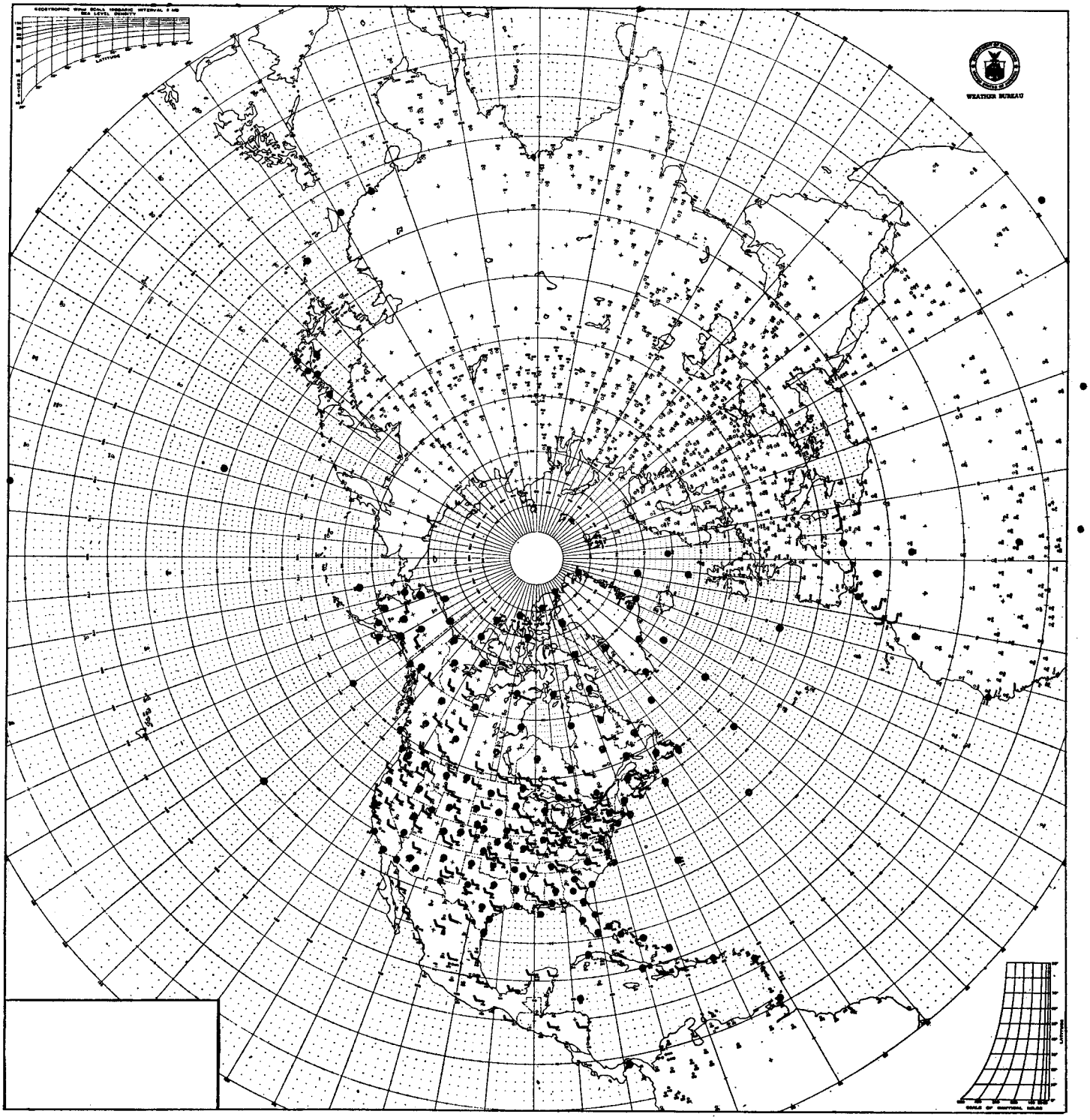

FIGURE 10.—500-mb. 1500 GMT reports normally plotted from standard teletypewriter source. Wind barb shows pibal data only received from that station.

the entire hemisphere, teletypewriter material as received by the Extended Forecast Section of the Weather Bureau and the National Weather Analysis Center in Washington, D. C., is forwarded on a regular basis to the NWRC for use on the current project. Use of the teletypewriter source for reports in the United States and Canada was explained above.

Because of the late receipt of some of the weather logs of ships, about half of the 200 to 250 ship reports plotted, and 450 to 500 tabulated for each day are taken from the teletypewriter source.

Many of the individual units in these sources overlap as to area covered, and the duplications of reports in the teletypewriter sources are so numerous that they defy accurate

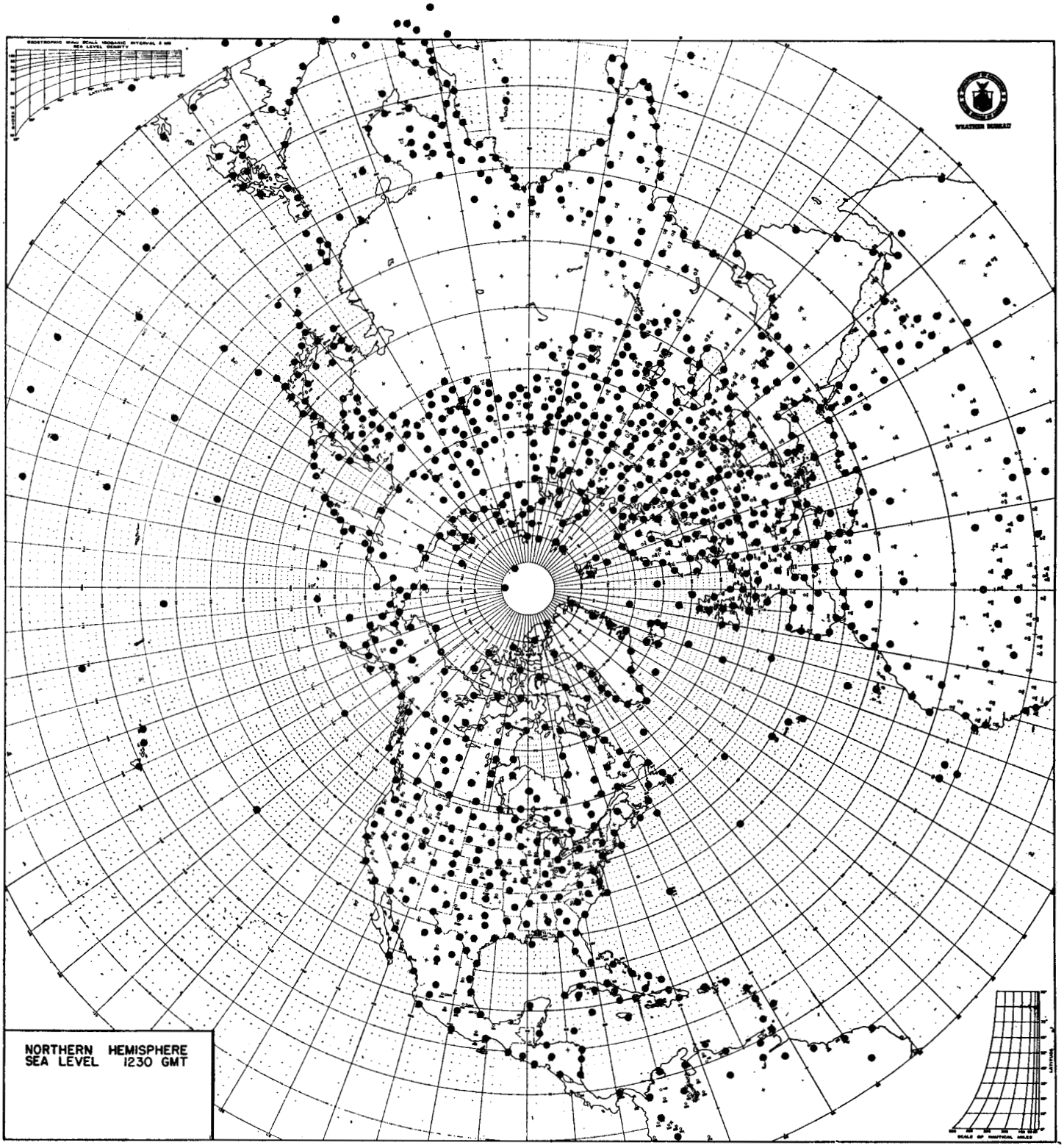

FIGURE 11.—Average sea level 1230 GMT coverage from multiple sources. (Ships-at-sea reports not shown.)

enumeration. The stations indicated as being included in a particular source on the maps are the ones that can normally be expected to appear in that source, and this is classed as the "primary" source for these stations; but because of a delayed shipment of records, the garbling or absence of a teletypewriter sequence, or a break in a series of publications, it is often necessary, and always desirable, to use another source although it may be a less reliable one. Under the 6-month lag, month-per-month production commitment of the current project, unlimited time is

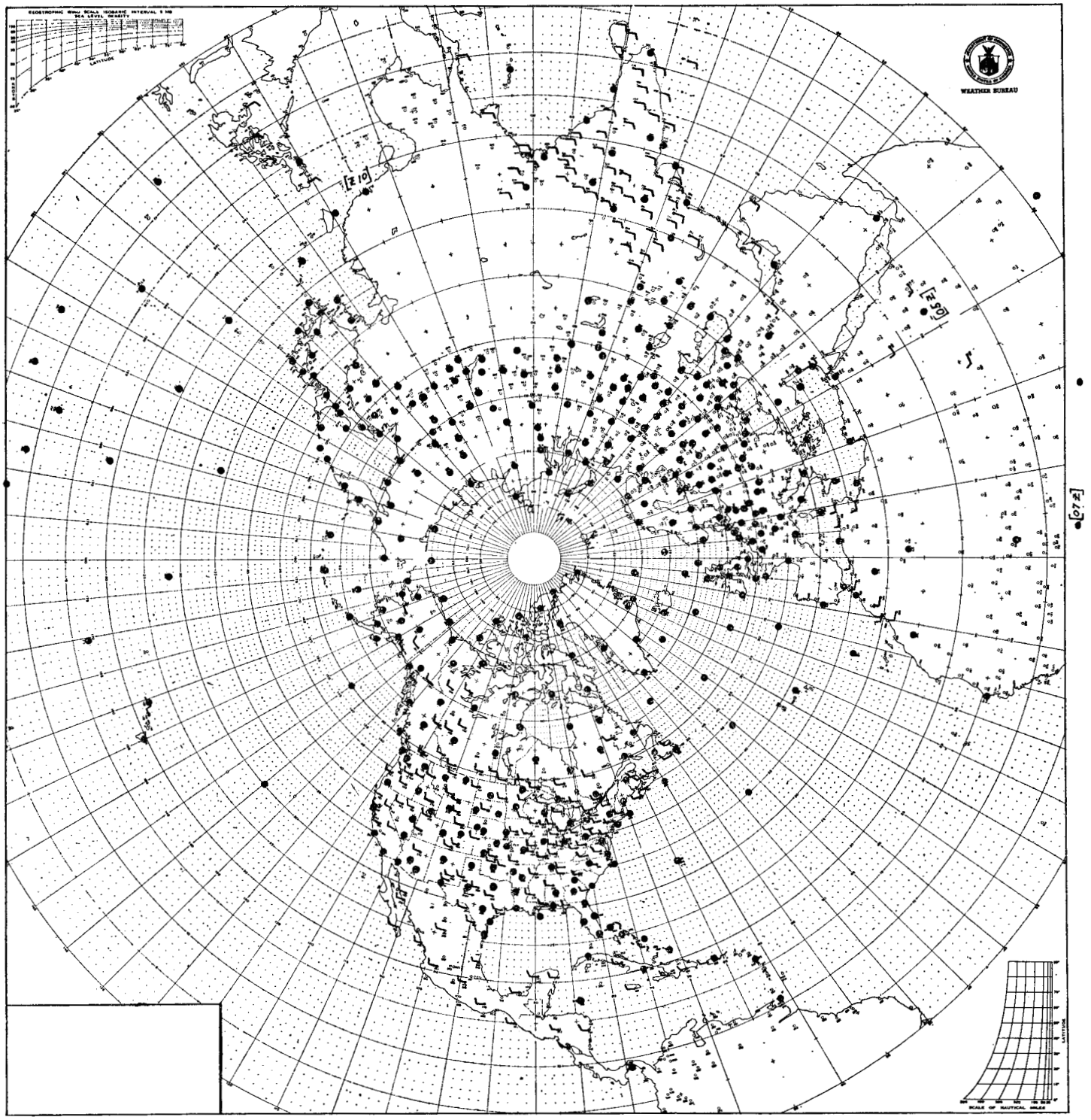

FIGURE 12.—Average 500-mb. 1500 GMT coverage from multiple sources. Wind barb shows pibal data only received from that station.

not available for data collection and editing. When data are missing from a primary source, plotters are obligated to plot the missing stations from another source if possible, but just how long to search for the missing data until the time spent outweighs the value of the data found is a continual problem.

COVERAGE FROM MULTIPLE SOURCES

Figures 11 and 12 are composite maps of the average coverage of reports plotted on the current Northern Hemisphere Series. From 200 to 250 reports from ships at sea are not indicated on the sea level map, and reports from reconnaissance aircraft normally plotted on the 500-mb. map are shown in figure 13. During the earlier years of the current series these in-flight reports generally were not plotted, but because of increased accuracy in more recent years they are found to be a definite aid in defining both the height and temperature field at 500 mb. Dropsonde data from in-flight reports supplement the sea level

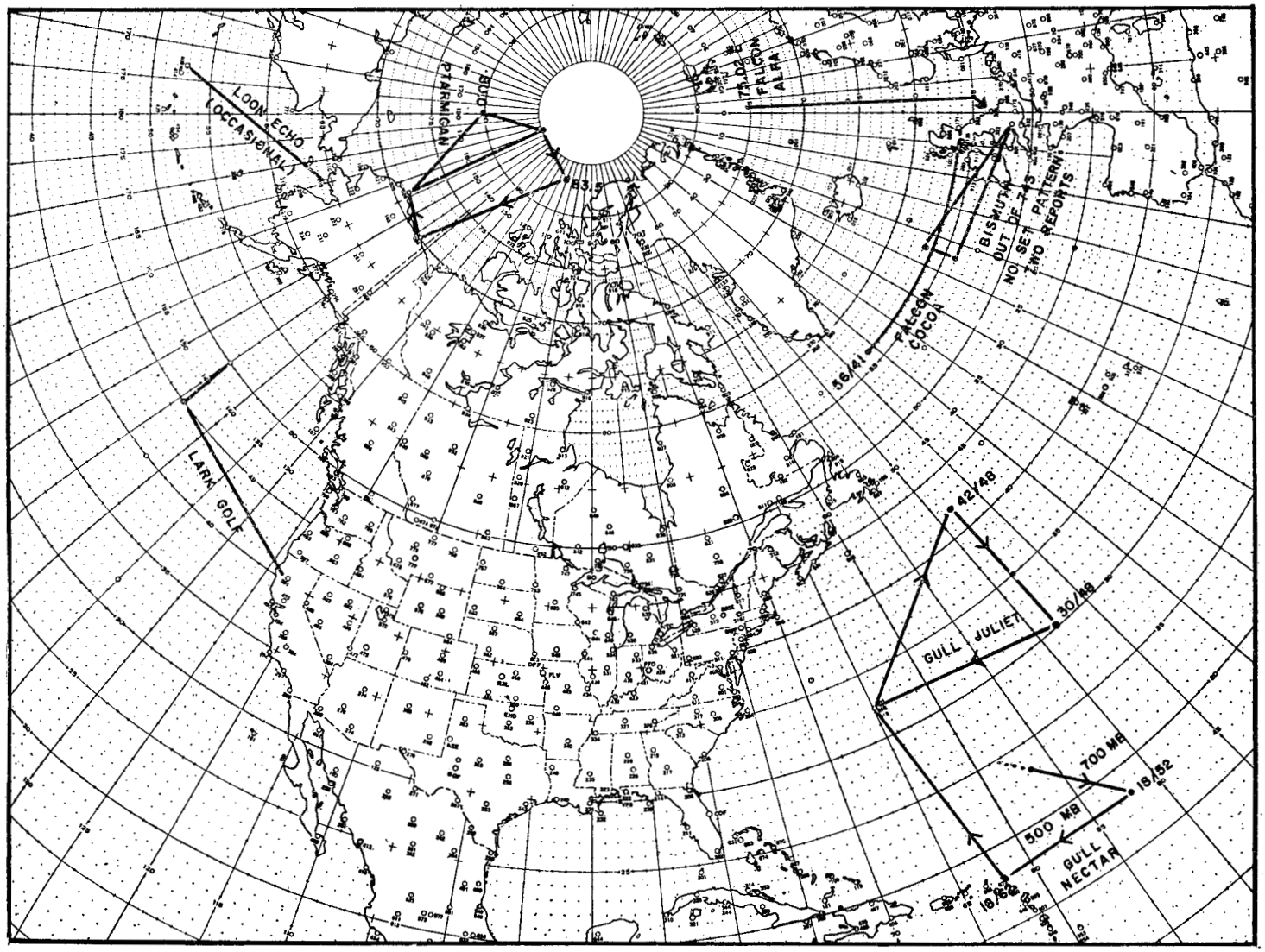

FIGURE 13.—500-mb. 1500 GMT flight reports normally plotted.

map when available. All in-flight reports are plotted from standard teletypewriter material.

As for grand totals, about 1100 reports normally are plotted on the sea level maps; 330 radiosonde reports and about 60 separate pilot balloon reports on the 500-mb. maps. As stated above, physical limitations restrict plotting to about 26 percent (300) of the sea level reports received from the Soviet Union. For the remainder of the hemisphere the scale of the plotting base (1:30,000,000) restricts the plottable stations to about 40 percent (800) of those available. By comparison, about 99 percent of the reports received at the 500-mb. surface are plottable.

The most marked area of a lack of reports on both the sea level and the 500-mb. maps is the general area of continental China and the plateau of south-central Asia. It is hoped that observational programs during the International Geophysical Year will be a large step forward in new data availability [3]. That this field is not dormant can be shown by comparing the "Data Density" map for January 17, 1953 [4] (not shown), with figures 3 and 12. Multiple data sources in the form of code sheets and original records show data availability improvements in Africa, the southwest Pacific, and the Philippines.

In addition to these specific areas, improvement has been shown in the total number of stations plotted since 1953—as a result of improved operational techniques within the project, as well as an increase in the content and quality of the data sources. For example, on days for which sea level data coverage was considered "above average", 1160 stations were plotted on a 1955 map as compared to 1004 in 1953, with over 100 of the additional reports plotted in the Soviet Union; since 1953 more than 40 additional 1500 GMT radiosonde reports from the Soviet Union are now plotted on the 500-mb. maps. It is apparent that some of this latter increase must be attributed to an accelerated upper air program in the Soviet Union during the last few years.

Failure of transmission of meteorological data by electrical means has long been a plague to the operational plotter and analyst. That this can be quite serious, and at the same time can be overcome by use of multiple data

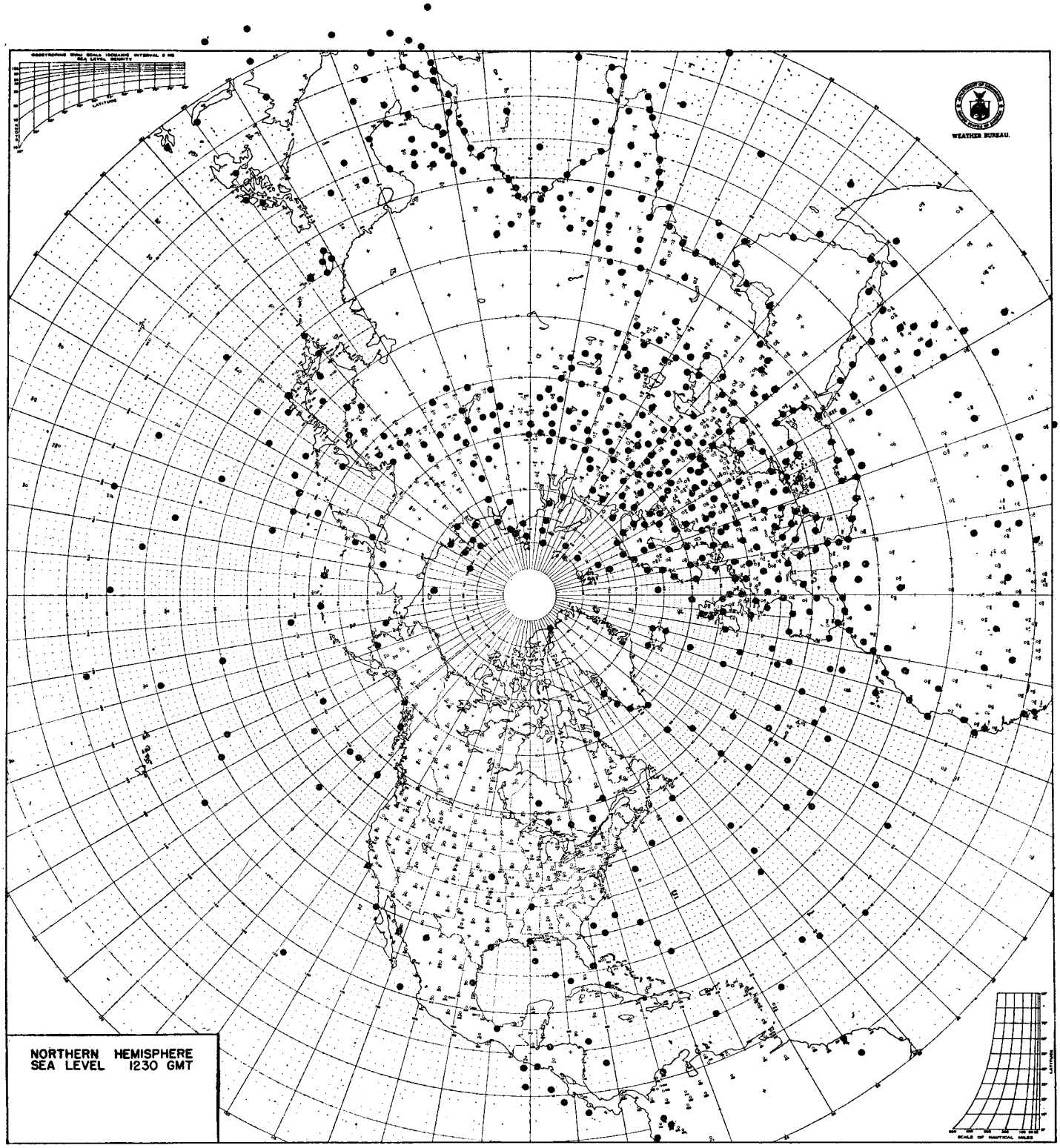

FIGURE 14.—Additional sea level 1230 GMT reports plotted from multiple sources on day of poor standard teletypewriter receipt.

sources with an extended period for data collection, is shown in figures 14 and 15. These maps show actual additional reports plotted from sources other than standard teletypewriter. The original operational map (Extended Forecast Section, November 17, 1955) was analyzed with over 600 1230 GMT reports less than the number available to the Northern Hemisphere current project analyst; the 500-mb. map (NWAC August 2, 1955) was analyzed operationally without the benefit of the 140 additional radiosonde reports and 32 pilot balloon reports shown in figure 15. Admittedly, these examples are selected exceptions and occur rather infrequently. How-

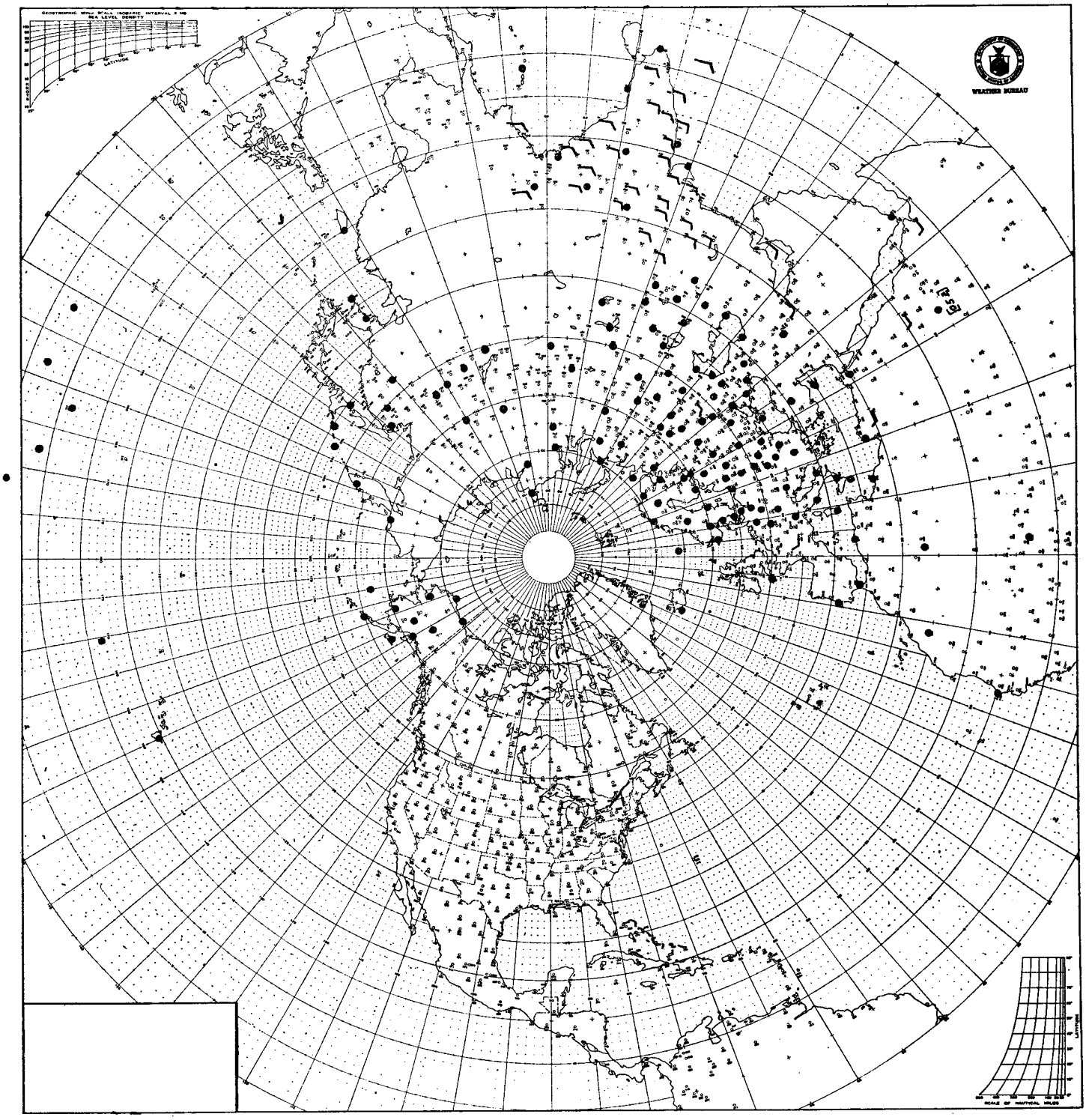

FIGURE 15.—Additional 500-mb. 1500 GMT reports plotted from multiple sources on day of poor standard teletypewriter receipt. Wind barb shows pibal data only received from that station.

ever, extended periods of aurora or other electrical interference can cause this incomplete receipt of data by standard teletypewriter to continue intermittently for some time.

EFFECT OF ADDITIONAL DATA ON ANALYSES

In an effort to show the effect of these additional data upon analysis, two operational maps were chosen at random, with the additional data available some months later from multiple sources spotted on maps shown in figures 16 and 17. These are examples chosen at random, but it is believed they show too marked a difference in data receipt. While *averages* have been determined as 300–325 *additional* reports on a current Northern Hemisphere sea level map, and about 35 *additional* reports on a

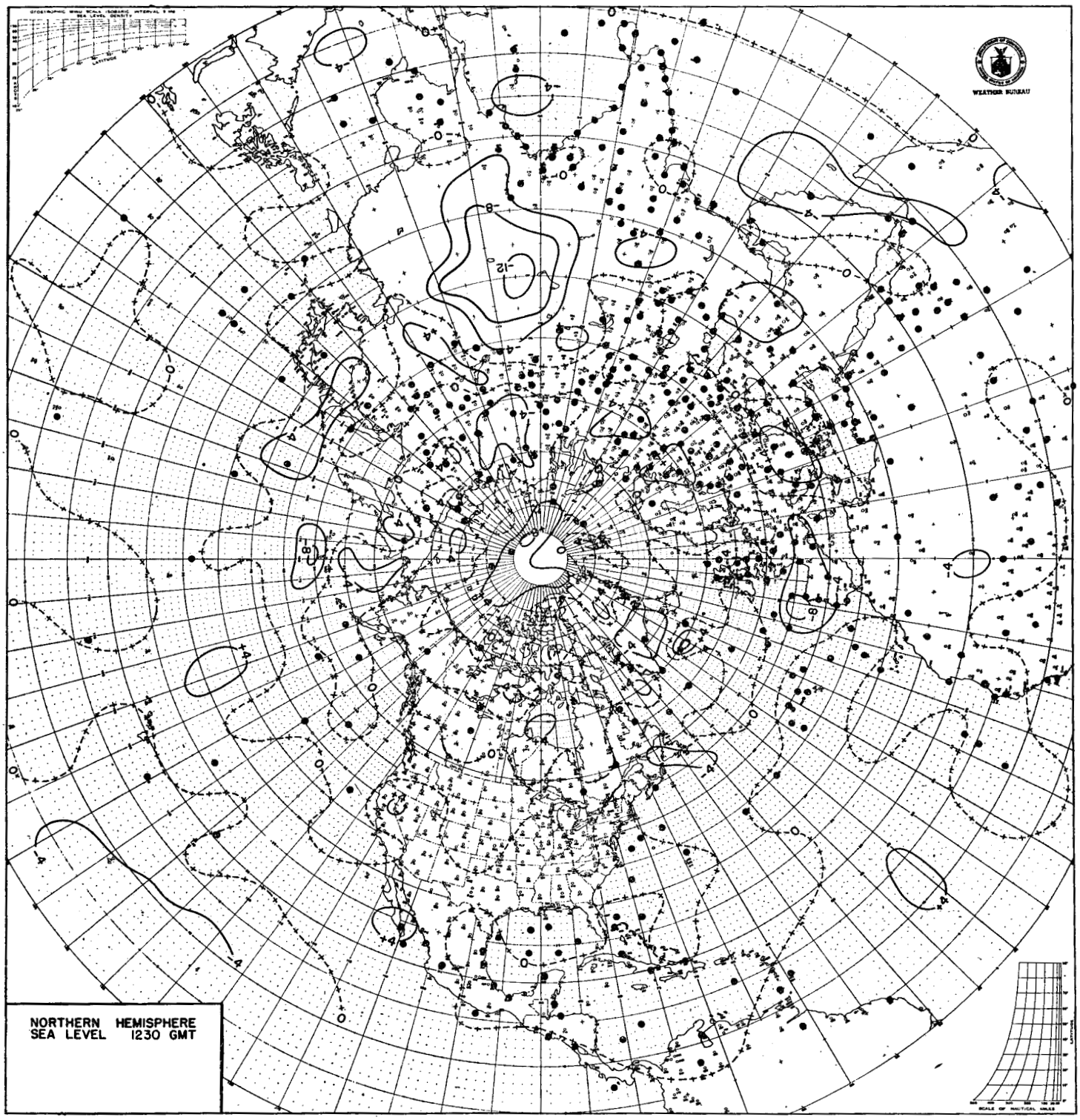

FIGURE 16.—Sea level 1230 GMT reports additional to those received in time for regular operational analysis, and isolines of significant difference between operational and Northern Hemisphere analyses. Significant difference: 0.66 mb.; interval: 4 "significants".

500-mb. map, these spotted maps show 419 and 114 additional reports respectively.

Values from the contours and isobars of the analyzed maps were read at grid intersections and a "difference" map was drawn. Since it is realized that two analyses of the same data by different analysts would not be exactly the same, the analysis difference over the United States, where little or no data were added, was taken as a basis of significance. Excesses of this difference (two-thirds of a millibar for the sea level analysis, and 30 ft. for the 500-mb. analysis) were considered significant and lines connecting values of equal significant differences (in increments of 4 "significants") in analyses are shown in figures 16 and 17.

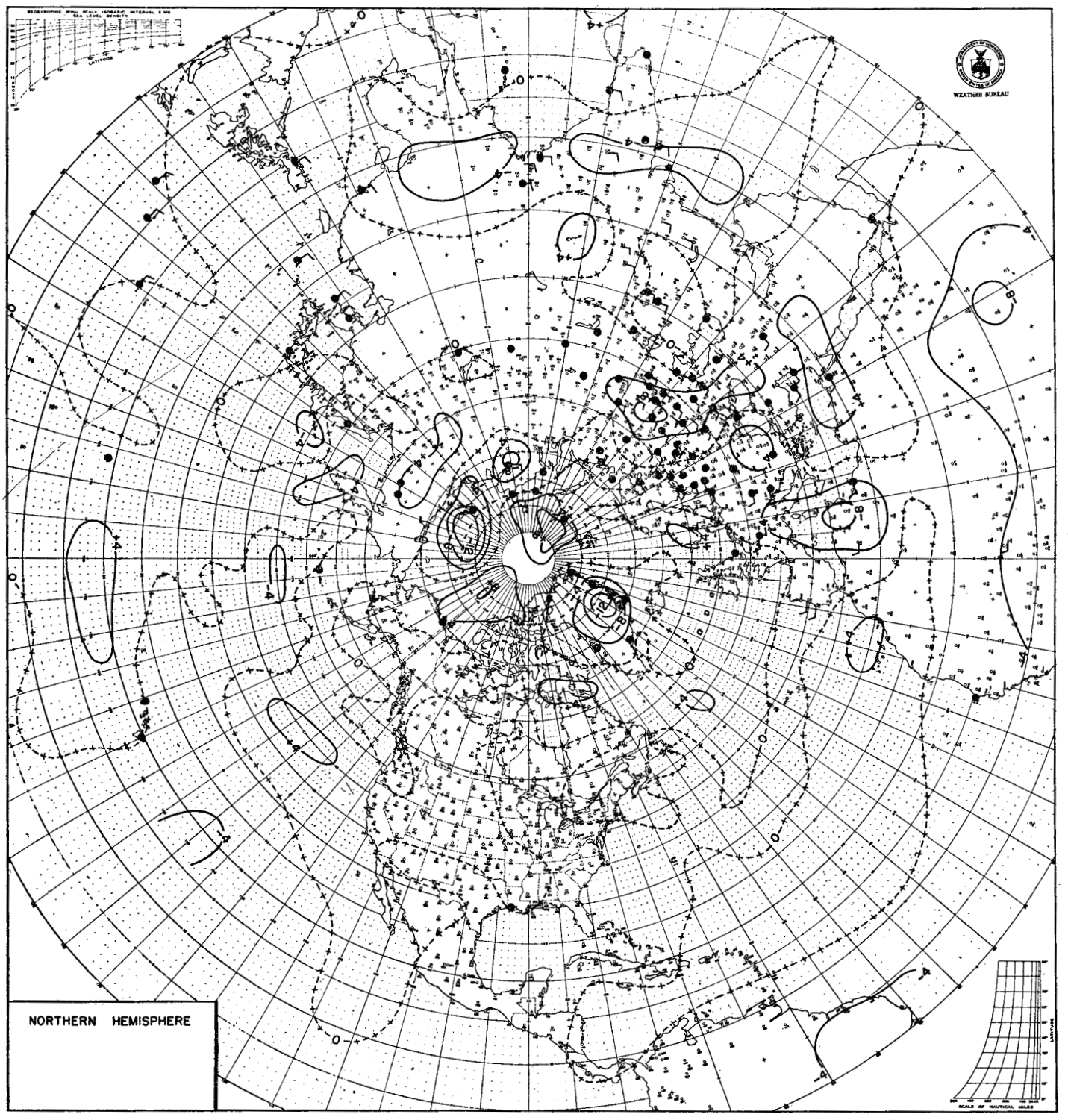

FIGURE 17.—500-mb. 1500 GMT reports additional to those received in time for regular operational analysis, and isolines of significant difference between operational and Northern Hemisphere analyses. Significant difference: 30 ft.; interval: 4 "significants". Dot and wind barb together indicate both height and wind data available for that station.

Not all of this difference is due to additional available data. Undoubtedly, every forecaster or analyst at some time has said to himself, "If I could only see the next map!"—and that is exactly what the Northern Hemisphere Series analyst does see—the next map. This advantage of establishing continuity by adjusting the present analysis in view of the map before and the map after, resulted in significant analysis differences most noticeably in the China area where no data were available on either set of maps, but where the analyst of the historical series had the advantage of "hindcasting."

On the sea level analysis (fig. 16), a large pressure fall in the vicinity of the Aleutians looked unreasonable to the operational analyst, but the subsequent rapid development

could be "anticipated" (with reference to the next map) by the historical analyst and this resulted in a large significant difference in analyses. In the north Atlantic, the addition of reports from Greenland, a few ship reports, and a dropsonde from an aircraft in-flight report helped to define the analysis and resulted in the relatively large significant difference shown.

Similar differences can be noted on the 500-mb. map (fig. 17). Generally, the greatest differences are in areas of greatest additional data—Greenland, the northern rim of the Soviet Union, and the west central Soviet Union.

While differences as large as 8 significants reflect absolute differences of only 5 mb. and 240 ft., it should be pointed out that the examples shown are for late summer situations with flat gradients. Equivalent data addition, with proportionate differences in observed elements, would tend to amplify the absolute differences in analyses in an active winter synoptic situation.

3. FUTURE PLANS

In addition to the filling of the two breaks in the main Northern Hemisphere Series as mentioned above and as shown in figure 1, it is evident that with the continued increase in the operating altitudes of modern aircraft, and the increased emphasis being placed on higher altitudes by many branches of science, an analyzed map of a higher level than the 500-mb. surface would be desirable in a series of this nature. While a map of the 300-mb. level would seem to be the next logical addition, the actual inclusion of another upper-level map is still in the thinking stage.

It can be definitely stated, however, that the personnel involved are dedicated to the continued consistent analysis of the charts both as a research tool and as an historical record, and the accurate tabulation of sea level and upper air data in the most convenient and usable form.

ACKNOWLEDGMENTS

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